2016-01-18

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Disabil Rehabil Assist Technol. 2010;5(6):462-9.
Taylor and Francis Group
http://doi.org/10.3109/17483107.2010.496098
http://hdl.handle.net/10616/44995

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DOI: **10.3109/17483107.2010.496098**

Ability to manage everyday technology: A comparison of persons with dementia or mild cognitive impairment and older adults without cognitive impairment

Abstract

Purpose: The ability to manage technology is important for performance and participation in everyday activities. This study compares the management of technology in everyday activities among people with mild-stage dementia or MCI with older adults without known cognitive impairment (OA). **Method:** Persons with mild-stage dementia (n=38), MCI (n=34) and OA (n=45) were observed and interviewed when managing their everyday technology at home by using the Management of Everyday Technology Assessment (META). A computer application of a Rasch measurement model was used to generate measures of participants' ability to manage technology. These measures were compared group-wise with ANCOVA. **Results**: The management of everyday technology was significantly more challenging for the samples with mild-stage AD or MCI compared to the OA sample (AD – OA, $p<0.001$; d=1.87, MCI – OA, $p<0.001$; d=0.66). The sample with MCI demonstrated a significantly higher ability to manage technology than the sample with mild-stage AD (AD – MCI, $p<0.001$; d=1.23). However, there were overlaps between the groups and decreased ability appeared in all groups. **Conclusions**: Persons with cognitive impairment are likely to have decreased ability to manage everyday technology. Since their decreased ability can have disabling consequences, ability to manage technology is important to consider when assessing ability to perform everyday activities.

Introduction

Dementia diseases are common diseases of old age with a prevalence of 27.7 million worldwide [1]. In the European Union, 5.5 million people are estimated to be diagnosed with dementia [1 and in the US, 3.8 million [2]. In the mild stage of dementia and sometimes even before a diagnosis is confirmed, executive abilities, e.g., planning, problem solving and initiation of actions, decline [3]. Other clinical symptoms of mild dementia are memory impairment [4], cognitive deterioration [5] and depression [6]. Due to these changes, the ability to perform instrumental activities of daily living (IADL), e.g., household activities, shopping and managing finances [7] is affected already in mild dementia. The most common form of dementia is Alzheimer's disease (AD) with about 65% of all dementia cases [8]. In contrast: the diagnostic definition of mild cognitive impairment (MCI) requires an essentially intact ability to perform activities of daily living (ADL) and IADL. MCI is described as an early, abnormal condition of cognitive impairment not severe enough to be classified as dementia. It is commonly referred to as a state in-between normal ageing and the diagnosis of probable, very early, dementia [9]. The probability of developing dementia from MCI is proposed to be high and the progression rate from MCI to dementia is approximately 12%-15% per year [10]. Reports of population-based prevalence for MCI range from 11% to 17% [11]. In contradiction to the criteria for MCI [9, 12] many recent studies have reported that people with MCI do experience subtle difficulties in complex everyday life activities [13-17]. Since these difficulties have been shown to be significantly more prevalent in people with MCI than in older adults without cognitive impairment [12-13, 16-18], it has been suggested that decline in complex IADLs, such as managing finances and using the telephone and household appliances, should be acknowledged in future MCI diagnostic investigations [15, 19]. Even mild IADL restriction in people with MCI is known to be associated with a higher risk of conversion to dementia [14]. However, it is still not known in what domains of IADL and to what extent people with MCI are affected compared to people with dementia and older adults without known cognitive impairment [20]. Therefore, further inquiry into the field of everyday functioning among people with MCI has been called for [21]. Additionally, development of more sensitive assessment methods that may detect changes in complex ADL/IADL ability in people with MCI or pre-clinical dementia that, for example, can enable early interventions has been requested [4, 14, 17, 21-23].

One way of investigating ability in complex IADL is to acknowledge the use of technology as a complicating aspect. As the use of technology increases in activities both in our homes and in society, we are expected to manage and interact with numerous technologies on a daily basis, e.g., coffee machines, microwave ovens and computers. Also, the performance of these activities thereby has changed [24], e.g., cash is received through the use of a cash machine instead of visits to a bank office. Earlier studies show that people with mild dementia or MCI may have a variety of technologies in their homes, even if their overall use has decreased and problems to use technology are common [16, 25-26]. In general, decreased ability to manage technologies in everyday life may bring about a risk for them being excluded from participation in activities at home as well as in society [27-28]. In a recent study by Rosenberg et al. [16], self-reported relevance and overall difficulty of everyday technology in people with mild dementia, people with MCI and older adults without known cognitive impairment were investigated. The sample with MCI was found to perceive everyday technology to be significantly more difficult to use compared to the sample without cognitive impairment, but significantly less difficult than those with dementia. In the present study, we continue the inquiry into the *observed* ability to manage everyday technology among older adults with or without cognitive impairment. Such observations might give valuable information about the ability to perform everyday activities in people with dementia or MCI and provide a base for supportive interventions.

This aim of this study, hence, was to investigate how older adults with mild AD or MCI manage technology, in the context where it is familiar and relevant to use, in everyday life activities in comparison to older adults with no known cognitive impairment (OA).

Method

Participants

Older adults with or without cognitive impairment living at home constituted the sample. In total 116 older adults in three groups were included: mild AD (n=38), MCI (n=33), and OA (n=45) (see table 1 for further presentation of the participants). The sample size for each group was estimated to at least 33 people, based on power analysis with a power of 0.8 and $p<0.05$, in order to secure a mean difference of 0.8 logits between groups to allow investigation of whether META has the ability to separate the three groups from each other according to competence in everyday technology use. Participants with AD (or AD mixed with vascular dementia) or MCI were recruited from investigation units for memory deficits and day-care centres for people with dementia in two urban areas in Sweden. The OA participants were recruited through voluntary retirement organizations such as the Society of Retirees and similar networks. The inclusion criteria for all participants was an age of 55 years or older. This was chosen because AD and MCI occur already in people of that age and because everyday technology use was proposed to be particularly important below the age of retirement as they are expected to participate fully in society. Participants should also engage in everyday activities, i.e., to some extent use technology. People with visual and/or hearing impairments were included as long as their impairment(s) could be compensated with technical aid(s). Participants with AD (or AD mixed with vascular dementia) had been diagnosed by physicians based on NINCDS-ADRDA (Mc Khann et al., 1984) and DSM-IV [29]. The participants with MCI were diagnosed based on the diagnostic criteria for MCI [19] subjective memory complaint, preferably corroborated by an informant, objective memory impairment for age, relatively preserved general cognition for age, essentially intact activities of daily living, and not demented. Finally, a no more than six-month old Mini-Mental State Evaluation, MMSE [30], score of minimum 18/30 for people with mild AD and 25/30 for people with MCI was used as an inclusion criterion. Information about diagnoses and up-to-date MMSE scores were gathered from the participants' medical files. People with AD or MCI were not included if they had other documented and diagnosed diseases that could cause their cognitive impairments, e.g., stroke or severe depression. Older adults with no known cognitive impairment and a newly assessed MMSE-score of a minimum 27/30 were included to match on a group level with their counterparts with AD or MCI regarding gender, age and years of education. Of those 179 invited, 63 persons, both people with AD (n=27), MCI (n=25) and OA (n=11), declined participation in the study. The decline had several explanations; 34 persons were not interested in participating in the study, 10 persons declined participation due to time constraint, 16 persons were not able to participate due to health-related or personal reasons and finally there were three persons that we could not reach. Approval was obtained from the Ethical Committee of the Karolinska Institutet before the initiation of the study (D-nr: 2005/1203-31).

[Insert table 1 here]

Seven trained raters collected the data. All of them were occupational therapists with particular experience of working clinically with people with dementia. Prior to using the META, all raters received a one-day course covering general information about the META and definitions, procedures and scoring criteria in order to maximize the accuracy of scoring [31]. To practice scoring, the raters also assessed an older adult's videotaped use of four everyday technologies before starting to collect data. Raters also participated in continuous discussions and received feedback in personal communication with the creator of the META (LN) during the data collection process.

Measures

The Management of Everyday Technology Assessment, META [32], was used to assess the participants' ability to manage everyday technology. The META has recently been developed to evaluate the ability to manage technology in everyday life for older adults in general and specifically for people with mild dementia or MCI. The META consists of ten items assessing observable performance skills that have been found essential for the ability to manage everyday technology [25]; examples of items are *to identify and separate objects, to turn a button or knob in the correct direction* and *to perform actions in a logical sequence*. People are observed and assessed on the ten items on a three-category scale by a rater, while using their own technology at home or in society. Those who are assessed also report their own perception of their performance and ability to manage the technology, as this is an important aspect to consider in clinical investigations. The psychometric properties of the META have been evaluated elsewhere indicating that the META has acceptable scale validity and also demonstrates acceptable person response validity and task goodness-of-fit. The META was in addition indicated to be able to separate individuals with higher ability from individuals with lower ability [33].

Procedures

Data were collected during two years, 2006-2008. Potential participants with AD or MCI were, based on inclusion criteria, identified by professionals at the units in collaboration with a member of the research group. Potential OA participants were recruited directly by members of the research group. First, all potential participants were sent written information about the study. Thereafter they were contacted by telephone and asked if they were willing to participate. People who agreed gave their verbal consent and a time for the assessment session in their home was scheduled. Data collection was, after written consent, performed in the participants' homes and/or in the community nearby, depending on the kind of technology to be assessed.

The participants were observed when using their own, relevant, self-chosen and currently used everyday technologies, e.g. cell phone, iron and automatic telephone services. The technologies also strived to be sufficiently challenging. This judgement was made by the rater for each participant, based on the hierarchy of everyday technology difficulty that had been created on the Everyday Technology Use Questionnaire [34]. After a short introductory interview, participants were asked to demonstrate their use of at least two technological artefacts or services (overall m=3.6 technologies/person, SD 1.50. OA m=3.1 SD 1.04. MCI m=4.3 SD 1.70. AD m=3.7 SD 1.52). While using the chosen technology, the participant's performance was observed and assessed by the rater on the ten items in the META using a three-category scale: 3=competent, 2=minor difficulties/problems and 1=obvious/major problems. If the rater hesitated in choosing between two scoring categories, the lowest score was always chosen. The META has a detailed manual with definitions of the items, scoring criteria and recommendations of how the assessment should be administered [32].

Data analysis

Initially raw scores, i.e., the raters' scores on items from assessments with the META, were converted through logistic transformation into abstract interval measures in units called log-odds probability units; logits, by using a computer application of the Rasch measurement model and FACETS, Version 3.61.0 [35]. With the FACETS analyses, all participants receive a measure of person ability presented in logits on an interval scale representing the measured construct, in this case the management of technology [36]. The psychometric properties of the META have been evaluated elsewhere and the examination of the person response validity indicated that 97.5% of the participants demonstrated acceptable goodness-of-fit to the Rasch measurement model [33]. This indicates acceptable person response validity in this sample of OA with or without cognitive impairment, and the person ability measures were assumed valid for further statistical analyses.

For evaluation of the data, the Statistical Package for Social Sciences [37] was applied. Analysis of covariance (ANCOVA) was performed to compare the ability to manage technology between the groups. The person ability measures generated from the FACETS analyses of the META data were used as the dependent variable. The effect on the measures of person ability was tested with a forward selection procedure with an inclusion criterion of $p<0.05$ with group as factor and age, gender, years of education and living conditions (single or co-habiting) used as covariates (see table 2). In the event of a significant main effect, post-hoc test LSD with a level of significance set at $p<0.05$ was used to investigate between which groups differences in measures of observed person ability were significant. Effect sizes for differences in the non-adjusted mean person ability measures to manage everyday technology were calculated using Cohen d [38]. Cohen d expresses the difference between the means divided by the pooled standard deviation units of the groups, with 0.2 generally considered as a small effect size, 0.5 as a moderate effect size, and 0.8 as a large effect size [39].

Results

All three groups significantly differed from each other in ability to manage everyday technology. The differences remained significant even when the effect of sex was taken into account. The results of the ANCOVA showed a significant main effect for groups (F [35.921], $p<0.001$). In comparisons between the groups with post-hoc test LSD, the MCI group differed significantly from the OA group ($p<0.001$; Cohen d=0.66) and the AD group (*p*<0.001 Cohen d=1.23). Additionally, the OA group significantly differed from the AD group (*p*<0.001; Cohen d=1.87). The effect sizes between all groups are considered as large [39]. The results also indicate that being a male increased the mean META measure with 0.325 logits. Age, years of education and living conditions did not contribute to the variance of ability to manage everyday technology (*p*- values less than 0.05). The person ability measures are presented group-wise in the graph in figure 1. Mean, range, standard deviation, significance and mean difference confidence interval (95%) of the adjusted person ability measures for the three groups are presented in table 3.

[Insert figure 1 here]

[Insert table 2 here]

[Insert table 3 here]

Discussion

The results of this study suggest that the ability to manage everyday technology was more challenging in the groups with mild AD or MCI compared to the group of OA even though there are overlaps between the groups. Furthermore, the group with MCI demonstrated a significantly lower ability to manage technology than the group of OA. However, difficulties to manage the technology appeared in all three groups. The results indicate that management of everyday technology is an aspect of IADL that is sensitive enough to detect early changes due to cognitive decline and also to differentiate between groups that differ in cognitive ability. Assessments with the META seem to be one method to identify these difficulties.

The findings that the group with mild AD or MCI had more decreased ability to manage everyday technology than the group of OA imply that they are at risk of being excluded from participation in everyday activities and of losing independence. Numerous everyday activities involve use of technology, e.g., preparing meals, shopping and managing finances [40] and since people with mild AD or MCI live at home, they need to manage and interact with everyday technology to the same extent as OA. Our data provide an extensive variety of examples of difficulties in everyday activities that caused participation restrictions. Examples of such difficulties were not being able to get money from the cash machine, i.e., not being able to manage one’s day-to-day economy or not being able to book a time in the laundry room due to change of a booking system from pen and paper to electronic booking. The consequences of these kinds of difficulties might have devastating consequences for participation in everyday life activities for the individual with cognitive impairment.. No doubt, technology is often a facilitator in performance of everyday activities, but our findings show that it is important for professionals to recognize that technology also can be a hinder. As suggested by Nygård & Starkhammar, technology can even be a potential hazard [25]. In our data, hazards were exemplified by a number of participants who showed difficulties to handle, for example, the stove which could have serious consequences such as fire. It is therefore important that health care personnel pay attention to their clients’ ability to use everyday technology in a safe way.

In particular, the group with MCI demonstrated having significantly lower ability to manage everyday technology than the group with OA. This is consistent with other studies that have found people with MCI to have difficulties in managing complex IADL [13-16] but differ from the current diagnostic criteria for MCI [9]. Hence, the result also supports recent research that suggests that the criteria for MCI may need to be reconsidered and revised [15, 41] in view of the fact that people with MCI do not seem to have an essentially intact IADL as the diagnostic criteria require. Also, even mild restrictions in IADL in people with MCI have been shown to be associated with a higher risk of conversion to dementia and to identify these people is therefore important [12, 14]. Assessment of ability to perform complex IADL should accordingly be incorporated in the clinical evaluation of MCI [42] as this could be used to identify older adults living in the community at risk for conversion to dementia [14, 23]. Together with the study of Rosenberg et al. [16], our study shows that the ability to manage everyday technology is a domain of IADL sensitive to subtle changes in cognitive decline. Hence, this domain is recommended for assessment when the aim is to detect older adults at risk of exclusion from participation in everyday activities and society and of developing dementia. It is however important to further evaluate the META before applying the assessment in clinical practice.

As shown in figure 1, there are no ceiling effects in our sample; all people evaluated received a measure of their abilities. Figure 1 also demonstrates that there are overlaps in ability to manage everyday technology between the three groups. These overlaps may have several explanations. Firstly, there are no strict diagnostic boundaries between the samples. Due to this, there are probably single individuals that have been included into a sample in which they do not belong although our criteria were strictly based on clinical examinations by physicians. Possibly, some individuals in the group of OA may have regarded a self-perceived memory decline to be a part of normal ageing and therefore had not been investigated [10]. As the OA group was included on their own identification as such, and only assessed with the MMSE, the group can by mistake have been classified as being without known cognitive impairment. Single individuals with MCI may also have developed a dementia or have reversed to normal cognition and functioning since their last examination at the memory clinic [43]. Since MCI is described as a transitional state in between the normal cognitive changes of ageing and mild dementia, MCI can of course cover a heterogeneous group with a broad spectrum of IADL-abilities. Another explanation to overlaps may be that ability to manage everyday technology is reliant on various aspects beside cognition, e.g., interests, habits, physical ability and motivation [44]. For example, in a qualitative study of people with dementia and their use of everyday technology, it was shown that the most important features for a successful use of technology for people with dementia were a frequent use, high motivation and need of the technology in combination with an embodied knowledge of the technology [26]. This might also explain the wide spread of person ability in the samples.

The sampling method can be seen as a limitation of the study. There is of course a risk that the invited participants are not representative for other older adults with or without cognitive impairment.. We did not have information about the type of MCI in the group with MCI. Depending on type of MCI, the ability to manage IADL seems to vary [42]. This can of course have influenced the results. The OA group was recruited from voluntary retirement organizations and similar networks. Certainly, there is also a risk that those individuals are not representative for older adults in general. Moreover, 34 potential participants were invited but declined participation due to not being interested to participate. Their decline could have been based on reasons that influenced the results; on the one hand, they may have lacked interest in technology and therefore declined participation. On the other hand, experiences of not having any problems to manage technology may also be their reason for decline. Hence, those who participated may be those interested in technology and/or those who experienced having problems with technology, which certainly may have affected the result in either direction. Furthermore, since raters were aware of the participants' group status, they may have been biased in their assessments. On the other hand, raters did not know beforehand which items in the META or which technologies that would be more or less challenging in the Rasch analysis which could minimize the risk for rater bias in the scores.

The results from this study provide some clinical implications. Firstly, this study indicates that people with mild AD or MCI have decreased ability to manage technology. This may have consequences in everyday life since technology has become an increasingly essential part of activities and participation in society [40]. Therefore, it is important to consider the ability to manage everyday technology, when assessing ability to perform everyday activities for people mild AD or MCI. Secondly, the thorough data collected with the META, can be used to guide interventions as well as to develop strategies to support everyday activities [18] where technology is required. The observations provide in-depth knowledge about the participants' ability to manage everyday technology, and the interviews give information about the participants' perceived ability. The professionals can, for example, colour mark important buttons on a CD-player, recommend technologies designed to require less challenging performance skills, or technologies that have a good match to their clients' skills and level of abilities. And last, assessments of the ability to manage everyday technology may be important to identify older adults at risk of developing dementia.

Acknowledgements: The authors first of all want to thank the participants who generously demonstrated their management of everyday technology for us. We also want to thank the professionals at the investigations units who helped us to recruit participants. Particularly, the authors would like to thank Sofia Starkhammar, Monica Pantzar, Jenny Rasmussen Tjernlund, Susanne Andersson, Lizette Mårtensson, and Maria Carlsson for data collection and management.

This research was mainly funded by the Health Care Sciences Postgraduate School. Financial support was also provided through the Botkyrka community, the Swedish Brainpower and the regional agreement on medical training and clinical research (ALF) between the Stockholm County Council and the Karolinska Institutet.

Earlier preliminary results were presented at the 4th Swedish Brainpower Workshop, September 25-26, 2008, Stockholm, Sweden and the 10th AAATE conference (Association for the Advancement of Assistive Technology in Europe), August 31st – September 2nd, 2009, Florence, Italy.

Declaration of interest

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of the paper.

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Table 1. Characteristics of the participants in terms of age, length of education, MMSE score, sex and living conditions and non-adjusted person ability measures in logits.

Group	OA	MCI	Mild AD
n	45	33	38
Age, year mean (SD)	73.22 (9.73)	70.45 (8.4)	75.29 (9.09)
Range	55-92	57-87	58-89
Education, year mean (SD)	11.08 (3.08)	11.14 (3.66)	10.45 (3.13)
Range	6-18	5-19.5	5-17
MMSE score, mean (SD)	29.27 (1.07)	27.52 (1.87)	23.53 (3.26)
Range	27-30	24-30	17-29
Sex, n (%)	Men: 16 (36) Women: 29	Men: 19 (58) Women: 14	Men: 18 (47) Women: 20
Living conditions, n (%)	Cohabiting: 23 (51) Single: 22	Cohabiting: 25 (76) Single: 8	Cohabiting: 20 (53) Single: 18
Non-adjusted person ability measure in logits, mean (SD)	2.24 (0.93)	1.65 (0.86)	0.73 (0.66)
Range	0.68-4.25	0.28-3.73	- 0.73-1.93

Table 2. Results of the ANCOVA forward selection procedure: Variables that might influence the measure of person ability were controlled for with an inclusion criterion of $p<0.05$.

Univariate model

Covariates	Effect	SE	95% CI		p
Group	-0.747	0.091	-0.928	-0.566	<0.001
Age	-0.013	0.008	-0.030	0.004	0.137
Sex	0.325	0.154	0.019	0.631	<0.05
Education	0.001	0.024	-0.046	0.049	0.963
Living conditions	0.195	0.160	-0.123	0.513	0.227

Final model

Covariates	Effect	SE	95% CI		p
Group*					
OA[a] vs. MCI[b]	0.649	0.190	0.273	1.026	<0.001
OA vs. AD[c]	1.533	0.181	1.174	1.891	<0.001
MCI vs. AD	0.883	0.196	0.496	1.271	<0.001
Sex** Men vs. women	0.325	0.154	0.019	0.631	<0.05

* Mean difference of post-hoc test.**Mean difference adjustment per unit of the independent variable. [a]OA= Older adults without known cognitive impairment, [b]MCI=mild cognitive impairment, [c]AD= Alzheimer's disease.

Table 3. Adjusted mean measures of person ability to manage everyday technology for each of the groups.

	Adjusted person ability measure (logits) Mean (SE)	Significance	Mean difference CI (95%)
Mild AD	0.732 (0.133)	AD vs. OA p<0.001	AD vs. OA 1.533 1.174 1.891

MCI	1.615	MCI vs. AD	MCI vs. AD
	(0.144)	p<0.001	0.883
			0.496 1.271
OA	2.264	OA vs. MCI	OA vs. MCI
	(0.123)	p<0.001	0.649
			0.273 1.026

Figure 1. Graph of groupwise distribution of non-adjusted person ability measures.

Measure (logits)	OA	MCI	Mild AD
	(n=45)	(n=33)	(n=38)
5			
	*		
4	*		
	*		
	**	*	
	***	*	
3		*	
	****	*	
	***		
	*	**	
	*****	*	
2	******	***	
	****	**	**
	**	*	**

	****	****	*
	**	*****	****
1		****	***
	**	***	********
	****	***	***
			**
		*	****
0			****
			*
			**
			**
–1			

Note: Every * represents one individual. A higher measure in logits represents a higher ability to manage everyday technology. Groupwise mean person ability measures: OA 2.24, MCI 1.65 and mild AD 0.73. Groupwise mean person ability measures adjusted for sex: OA 2.26, MCI 1.62 and mild AD 0.73.